Japan Patent Office
Kokai Patent Publication No. 193608 - 1997, July 29, 1997

(21) Patent Application No. 8065 - 1996
(22) Date of Application : Jan. 22, 1996

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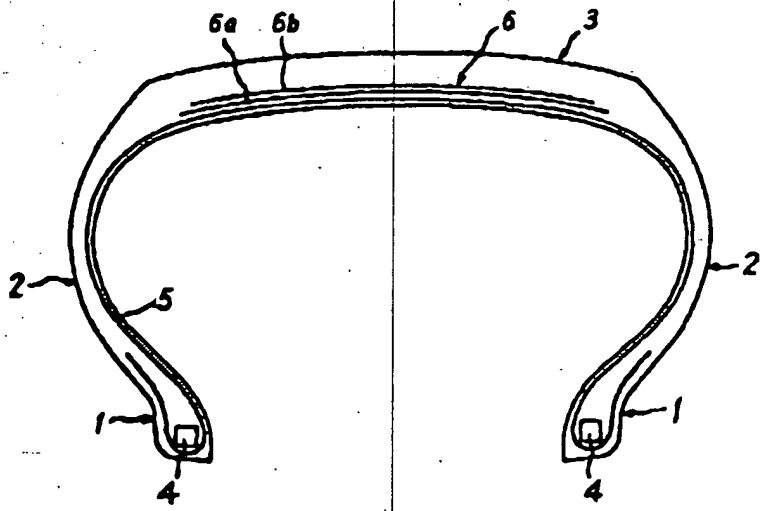
(54) [Title of Invention] Pneumatic radial tire

(57) [Abstract]

[Problem] To provide the pneumatic radial tire for which weight reduction is possible while maintaining the operational stability and high speed durability at high levels.

[Means of Solution] Pneumatic radial tire comprising the belt which has at least 1 layer or more of the cord- intersecting layers and at least 1 layer of the spirally wound layer of cord that is placed at the side of outer periphery of the said cord-intersecting layers, in which at least one layer of the cord in the spirally wound layer consists of the non-twisted organic fiber of multi filament has a denier in the range of 500 ~ 6000 denier per piece.



[Claims of the Patent]

[Claim 1] Pneumatic radial tire which is characterized by that,

in the pneumatic radial tire which comprises 1 or more plies of radial carcass which reinforces a pair of bead sections, a pair of sidewall sections and the tread section together between the bead cores which are embedded in the bead section and the belt which consists of 2 or more layers of cord - intersecting layers which reinforces the tread section at the outer periphery of the said carcass,

at least 1 layer of the cords of the belt consist of the no-twist organic fiber of multi filaments with the denier of one cord being in the range of 500 ~ 6000.

[Claim 2] The tire described in Claim 1 in which the said no-twist organic fiber is any one type among the aromatic polyamide, poly ethylene tere phthalate, poly ethylene naphthalate and poly vinyl alcohol.

[Claim 3] Pneumatic radial tire which is characterized by that,

in the pneumatic radial tire which comprises 1 or more plies of radial carcass which reinforces a pair of bead sections, a pair of sidewall sections and the tread section together between the bead cores which are embedded in the bead section and the belt which reinforces the tread section at the outer periphery of the said carcass, the belt comprising two or more layers of cord-intersecting layers and at least 1 layer of the spirally wound layer of cord which is positioned at the side of outer periphery of it,

at least 1 layer of the cords of the said spirally wound layer consist of the no-twist organic fiber of multi filaments with the denier of one cord being in the range of 500 ~ 6000.

[Claim 4] The tire described in Claim 3 in which the no-twist organic fiber cord of the spirally wound layer consists of aliphatic polyamide fiber.

[Detailed Description of the Invention]

[0001]
[Field of Technology to Which the Invention Belongs] This invention is related to pneumatic radial tire. In particular

it is related to the lightweighted pneumatic radial tire which maintains high speed durability and operational stability at high levels.

[0002]
[Existing Technology] From the past to the present, for the cord-intersecting layer in the belt of pneumatic radial tires for the passenger cars, in particular, the steel cord made by twisting thin steel wires together or the double twisted organic fiber cord of the fiber such as aramid has been used conventionally. Also, among the passenger car tires, for the tires which are used in the flat high speed running, it was also conventional to use another type of belt in which the so called cap layer is placed at the outer periphery of the cord-intersecting layer to cover the said layer. For the cord of this cap layer, it has also been conventional to arrange the organic fiber cord in spiral winding at the outer periphery of the cord-intersecting layer.

[0003]
[The Problem Which the Invention Intends to Solve] The tire having the above described belt construction can exhibit excellent operation stability and the latter tire can exhibit the desired high speed durability in addition to this performance. However, on the other hand, limitation occurs in regard to the further reduction of weight because of the need to maintain the two performances at high levels and thus it was regarded unavoidable that this weight reduction requirement can not be met.

[0004] Therefore, the objective of this invention is to provide the pneumatic radial tire for which further weight reduction is possible while maintaining both of the operational stability and high speed durability at high levels, on the premise of using the organic fiber cord, which is excellent in terms of lightweightedness, in at least 1 layer of the belt cord layers.

[0005] The inventor noticed the fact that the organic fiber cord of the belt in the tire product has cylindrical shape and that this defines the thickness of the belt and so accomplished this invention.

[0006] Thus, in order to achieve the above described objective, the pneumatic radial which is due to the first of this invention is characterized by that,

in the pneumatic radial tire which comprises 1 or more plies of radial carcass which reinforces a pair of bead sections, a pair of sidewall sections and the tread section together between the bead cores which are embedded in the bead section and the belt which consists of 2 or more layers of cord

- intersecting layers which reinforces the tread section at the outer periphery of the said carcass,

at least 1 layer of the cords of the belt consist of the no-twist organic fiber of multi filaments with the denier of one cord being in the range of 500 ~ 6000.

[0007] In the preferred example of application of the first of this invention, the above said non-twisted organic fiber is one type of fiber among the aromatic poly amide, poly ethylene tere phthalate, poly ethylene naphthalate and poly vinyl alcohol.

[0008] The pneumatic radial tire which is due to the second of this invention is characterized by that,

in the pneumatic radial tire which comprises 1 or more plies of radial carcass which reinforces a pair of bead sections, a pair of sidewall sections and the tread section together between the bead cores which are embedded in the bead section and the belt which reinforces the tread section at the outer periphery of the said carcass, the belt comprising two or more layers of cord-intersecting layers and at least 1 layer of the spirally wound layer of cord which is positioned at the side of outer periphery of it,

at least 1 layer of the cords of the said spirally wound layer consist of the no-twist organic fiber of multi filaments with the denier of one cord being in the range of 500 ~ 6000.

[0009] In the preferred example of application of the second of this invention, the no-twist organic fiber cord of the spirally wound layer consists of aliphatic polyamide fiber.

[0010]
[Mode of Application of the Invention] The first and the second of this invention are explained below in detail by using Fig. 1 ~ Fig. 4. Fig. 1 and Fig. 2 are the line diagrams showing the cross sections by the plane that contains the center of rotating axis of the pneumatic radial tires of an example of application (A) of the first of this invention and an example of application (B) of the second of this invention. In Fig. 1 and 2, 1 is the bead section, 2 is the sidewall section and 3 is the tread section. Each of these sections 1, 2, 3 are reinforced by the radial carcass 5 that runs between the bead cores 4 which are embedded in the bead sections 1.

[0011] The Example of Application (A) of the first of this invention comprises the belt 6 shown in Fig. 1 and the belt 6 consists of 2 or more layers (2 layers in the example

shown in the figure) of the cord-intersecting layers 6a, 6b. Here, the cord-intersecting layer means that the cords of the cord layers 6a, 6b are in a slanted configuration of intersecting with the tire's equatorial plane in between. Here, at least one layer (2 layers in this example) of the belt 6 consists of a non-twisted organic fiber of the cord which has a denier in the range of 500 ~ 6000 denier (D) per piece.

[0012] As for the above said non-twisted organic fiber, any one of the following is suitable: aromatic polyamide (area-mid) fiber, poly ethylene terephthalate (PET) fiber, poly ethylene naphthalate (PEN) fiber and polyvinyl alcohol (PVA) fiber. Referring to Fig. 3 (a) which shows in a schematic diagram a part of the cross section where the cord layer 6a and cord layer 6b intersect perpendicularly in the cord configuration, this non-twisted organic fiber cord C_A is arranged in the layer such that the number of cords placed per 5 cm in Fig. 3 (a) is 20 ~ 70 depending on the denier. Also, Fig. 3 (b) is the similar schematic cross section diagram of the existing belt cord layer.

[0013] The Example of Application (B) of the second of this invention comprises the belt 7 shown in Fig. 2. This belt 7 comprises the cord layers 7a, 7b which are similar to the above described cord-intersecting layers and at least 1 layer (1 layer in the example shown in the figure) of the spirally wound layer 7c of the cord which is positioned at the outer periphery of the outer side cord layer 7b. In this case, the cord of the spirally wound layer 7c consists of the non-twisted organic fiber of the denier which is in the range of 500 ~ 6000 denier (D) per piece.

[0014] The spiral winding of this cord can be obtained by using unvalcanized ribbon in which a plural number (3 pieces in the example shown in the figure) cords are embedded laterally to spirally wind over the cord-intersecting layer part in the so called second molding process in the tire molding process. From the product tire after the vulcanizing molding, the part which corresponds to one piece of the said unvalcanized ribbon was taken out at the cross section which perpendicularly intersects in the direction of cord alignment and this is shown in the schematic oblique view of Fig. 4 (a). The non-twisted organic fiber cord Cn of the spirally wound layer 7c is arranged in the layer such that the number of cords being placed is 20 ~ 70 pieces per 5 cm depending on the denier. Also, the cord layer 7c can be formed by spiral winding of one piece of rubber-coated cord.

[0015] As for the organic fiber cord Cn of the cord layer 7c, aliphatic polyamide such as 6-nylon, 6,6 - nylon are suitable advantageously.

[0016] The above described Example of Application (A) and Example of Application (B) are independently useful in the application to the belts 6 and 7 of pneumatic radial tires; on the other hand, one can combine Example of Application (A) to Example of Application (B).

[0017] The existing cord Cn which corresponds to the Examples of Application (A), (B), shows approximately circular envelope of the cord cross section as shown in Fig. 3 (b), Fig. 4 (b) which indicate the schematic cross section which perpendicularly intersect with the direction of cord alignment as in Fig. 3 (a) and Fig. 4 (a) (in the embedded rubber, approximately cylindrical shape is exhibited), while the above described non-twisted organic fiber cords C_A, C_B exhibit an ultra oblate shape in which the long axis is much larger than the short axis in the cord cross section as shown in Fig. 3 (a) and Fig. 4 (a), at least in the tire product. Therefore, the thickness of the cord layers 6a, 6b, 7c which have the non-twisted organic fiber cords C_A, C_B can be made much thinner than that of the existing cord layer and, by this, further weight reduction of one layer is possible.

[0018] Next, the non-twisted organic fiber cords C_A, C_B do not have any loss due to the twist and the elongational modulus of the cord can be utilized to the maximum ; so, for the tire of Example of Application (A), the aromatic polyamide (aramid) fiber which inherently has high modulus is most suitable. But, even if the fibers like PET, PEN having lower modulus than this fiber is used, rigidity of the belt 6 is higher than the rigidity of the existing tire and so both of the high speed durability and operational stability are over the level of the existing tire. Also, with the tire of Example of Application (B) also, the high speed durability and operational stability which are superior to the existing tires as described above can be exhibited.

[0019]
[Examples of Application] With the pneumatic radial tires for the passenger cars, the size was 205/ 65R15. The carcass 5 was 1 ply and had the radial configuration of the poly estser cord of 1500 D/ 2. As for the construction, Example of Application (A) followed Fig. 1 and Example of Application (B) followed Fig. 2. Particularly in regard to the belt construction, belt 6 of Example of Application (A) consisted of 2 layers of the cord-intersecting layers 6a, 6b and, for these 2 layers, the non-twisted organic fiber cord was used. Belt 7 of Example of Application (B) consisted of 2 layers of steel cord-intersecting layers 7a, 7b and 1 layer of the spirally wound layer 7c; for the layer 7c, the non-twisted organic fiber cord was used and the arrangement of this cord was made to be approximately parallel with respect to the tire equatorial plane. All of the cords was prepared by the

common treatment conditions. For both of Examples of Application (A) and (B), 4 examples of tires were made.

[0020] To check the effect of Example of Application (A) (Examples of Application 1 ~ 4) and Example of Application (B) (Examples of Application 5 ~ 8), the tires of corresponding Comparative Examples 1 ~ 4, Comparative Examples 5 ~ 7 were made, respectively, and, for all of these tires, the tire weight was measured and the tests for the evaluation of high speed durability and operational stability were conduct-ed. For the cord-intersecting layers 6a, 6b and the spirally wound layer 7c, the cord construction, the results of weight measurement and the results of performance tests are shown in Table 1 for the Example of Application (A) and Comparative Examples 1 ~ 4 corresponding to this, and in Table 2 for the Example of Application (B) and Comparative Examples 5 ~ 7 corresponding to this. Among the cord materials of each table, aramid was abbreviated by AM, nylon by NY and steel cord by STC, respectively. For the steel cord, the twist construction was described in place of the total denier.

[0021] [Table 1]

I	項目		実施例 (A)				比較例			
			1	2	3	4	1	2	3	4
1	交差層 6a 6b	コード材質	AM	PET	PET	PEN	ST	AM	PET	PET
2		総デニール(D)	3000	3000	4500	4500	1×5	3000	500	7500
3		撚数(回/10cm)	0	0	0	0	-	30	0	0
4		打込(本/5cm)	45	45	38	38	40	45	90	18
5	タイヤ重量(kg)		9.30	9.30	9.40	9.40	9.70	9.70	9.20	9.80
6	操縦安定性(指数)		101	100	101	101	100	100	95	102

EA. Example of Application; CE. Comparative Example; I. Item

1 ~ 4. Intersecting layers 6a, 6b; 1. Cord material; 2. Total denier (D); 3. Twist number (twists/ 10 cm); 4. Ends per unit length (ends/ 5 cm);

5. Tire weight (Kg) ; 6. Operational stability (index)

[0022] [Table 2]

I EA* *【表2】 CE

	項目		実施例(B)				比較例		
			5	6	7	8	5	6	7
1	巻回層7c	コード材質	NY	NY	NY	NY	NY	NY	NY
2		総デニール(D)	1260	1890	2520	3780	2520	2520	6300
3		撚数(回/10cm)	0	0	0	0	15	40	0
4		打込(本/5cm)	55	50	45	40	45	45	18
5	タイヤ重量(kg)		9.30	9.35	9.40	9.50	9.70	9.70	9.80
6	操縦安定性(指数)		101	102	103	104	100	99	104
7	高速耐久性(指数)		101	101	101	101	100	99	100

EA. Example of Application; CE. Comparative Example; I. Item

1 ~ 4. Wound layer 7c; 1. Cord material; 2. Total denier (D); 3. Twist number (twists/ 10 cm); 4. Ends per unit length (ends/ 5 cm);

5. Tire weight (Kg) ; 6. Operational stability (index) ; 7. High speed durability (index)

[0023] In the evaluation of operational stability, the test tire was mounted on the 4 wheels of actual passenger car and the car was run on the test course by experienced test driver and grade was given by the sensual evaluation of driver and the grade points were expressed by the index based on taking the Comparative Example 1 and Comparative Example 5 as 100. A larger value indicates better operational stability.

[0024] High speed durability test was conducted for the tire of Example of Application (B) and its Comparative Examples 5 ~ 7. In the test evaluation, each test tire was inflated to an internal pressure of 2.0 kgf/ cm2 and the load corresponding to this internal pressure was applied by the weight which is set by the JATMA YEAR BOOK. Then the tire was pressed against the test drum. The outer circumferential speed of drum was increased by an increment of 10 kg/ h at every 10 minutes elapsing. The speed at the occurrence of a disorder in the tire was expressed by an index based on Comparative Example 5 taken as 100. A larger value indicates better high speed durability.

[0025] As is clear from Table 1, in each tire of Example of Application (A), the non-twisted organic fiber cord was used

in the cord-intersecting layers 6a, 6b of the belt 6 and so the thickness of belt 6 could be made much thinner than the tires of Comparative Examples and, as the result, the tire weight could be effectively reduced. Also, the effect of high modulus of the non-twisted cord appeared and, even if the PET, PEN cord which have lower modulus than aramid are used, the operational stability is above the Comparative Examples 1 and 2 where steel cord and aramid were used in the belt and thus it was proven that the operational stability of tire could be maintained at high level.

[0026] In Table 2, again the non-twisted organic fiber cord was used in the spirally wound layer and, by this, the disadvantageous weight increase by the addition of the spirally wound layer of cord was kept to the minimum ; in addition, it is seen that both performances of high speed durability and operational stability of tire could be exhibited at the higher level than Comparative Examples 5 and 6.

[0027]
[Effectiveness of the Invention] By this invention, the non-twisted organic fiber cord is used at a part or whole of the cord layer of belt and, consequently, while maintaining the operational stability and high speed durability superior to the existing tires, the tire weight can be reduced advantageously. Thus, the pneumatic radial tire which can meet the demand of weight reduction sufficiently can be provided.

[Brief Description of the Figures]

[Fig. 1] is a line diagram of the cross section of an example of application of the pneumatic radial tire which is due to this invention.

[Fig. 2] is a line diagram of the cross section of another example of application of the pneumatic radial tire which is due to this invention.

[Fig. 3] is a partial cross section diagram of the cord-intersecting layer of belt of the tire shown in Fig. 1.

[Fig. 4] is an oblique view of a partial cross section of the spirally wound layer of belt cord of the tire shown in Fig. 2.

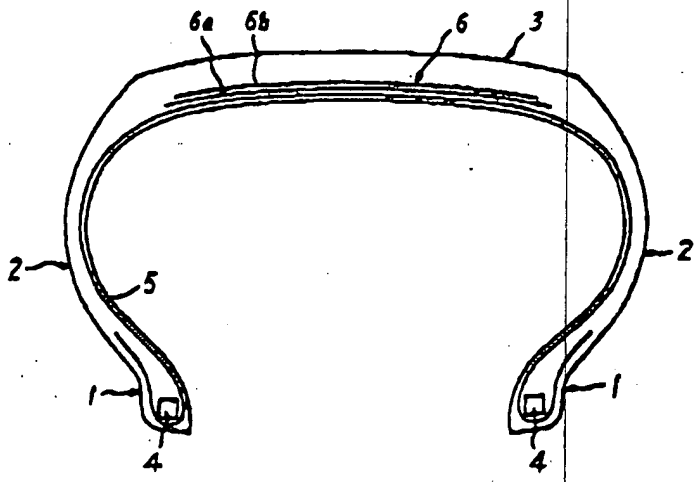
[Explanation of the codes]

1. Bead section; 2. Sidewall section; 3. Tread section; 4. Bead core; 5. Radial carcass; 6, 7. Belt

6a、6b、7a、7b　ベルトコード交差層

7c　コード螺旋巻回層

【図1】



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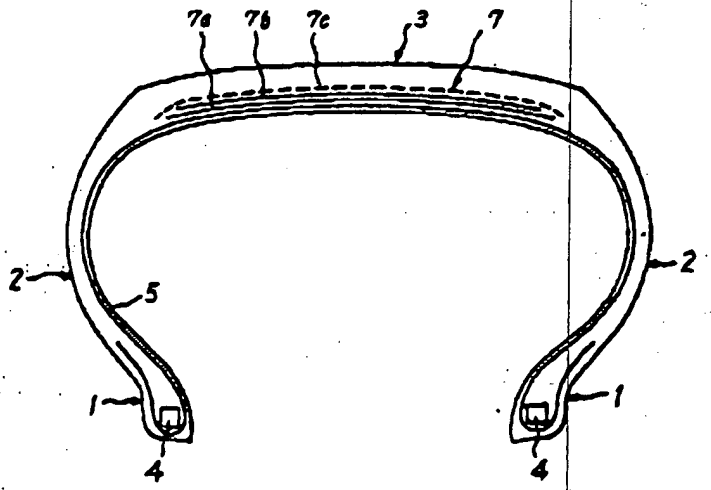
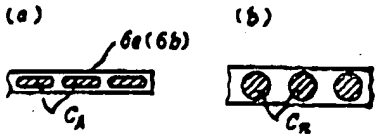


【図3】



【図4】